The GANSSER Project

Mountains and earthquakes

On a seismology project in Bhutan

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Mountains and earthquakes belong to each other.

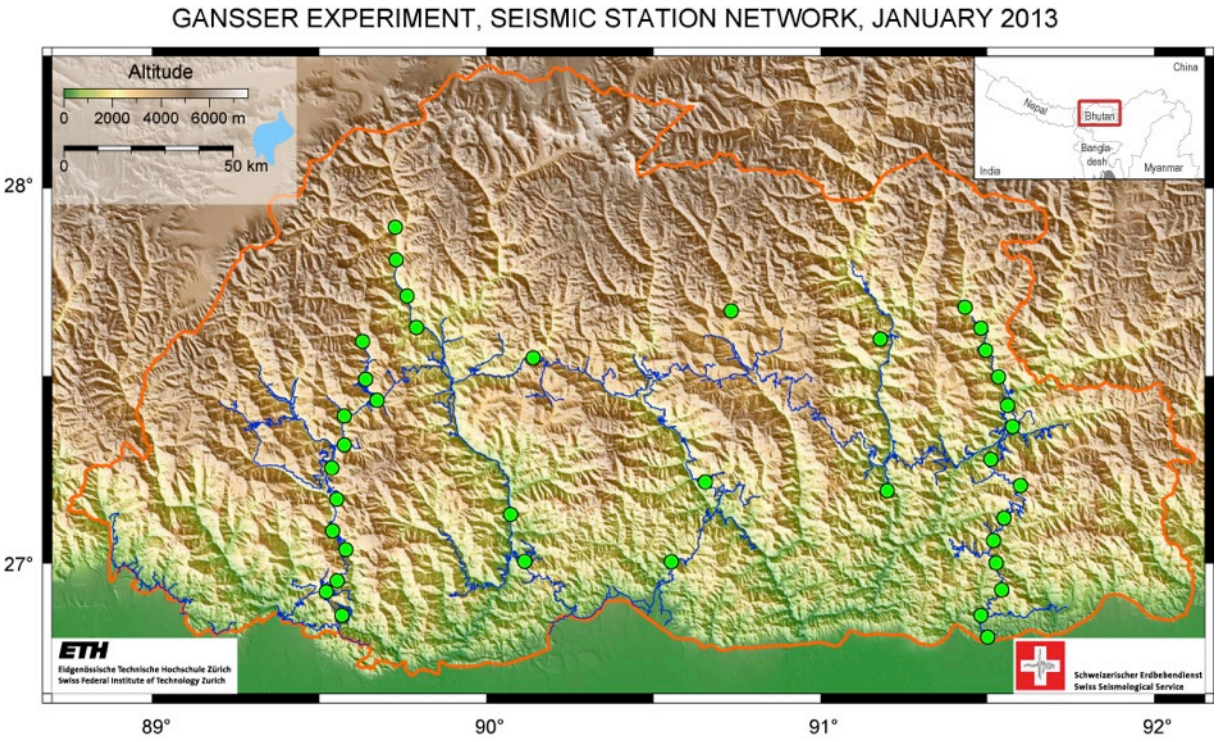
Large mountain chains such as the Alps and the Himalayas are the result of a long lasting geological process, plate tectonics. Over millions of years, continents drift on the surface of the Earth. When they slowly but steadily collide with another continent, the large masses of rock involved create a mountain range. The peaks of the Alps reach almost 5, those of the Himalayas almost 9 kilometres altitude. As different layers of rocks in the Earth have different densities these mountains also have a root to balance the peaks, similarly to an iceberg floating in water: the Alpine root reaches ca. 55, the Himalayan ca. 80 km depth.

How do relatively flat continents and large rock masses deform to create such high mountains and such deep roots? By producing earthquakes! Rocks deform by fractures which correspond to small to medium size earthquakes; these happen almost every day. Two tectonic plates that slide on each other produce major destructing events every “once in a while”. This time is relatively long and unpredictable on the scale of human life; nevertheless, it appears relatively regular on the scale of millions of years during which earthquakes release the stress accumulating from plate motions.

Bhutan is a prime example where these processes can be studied. The India plate plunges beneath Eurasia to form the vast Tibetan Plateau and the high Himalayan peaks. Small earthquakes are felt regularly by the population. Almost every Bhutanese will experience a middle size earthquake in his or her life, such as the 2009 magnitude M6.1 Mongar or the 2011 M6.9 North Sikkim earthquake. Large earthquakes, however, remain so rare that we do not even have a sure record of the last big event. The major events of the past 120 years in the area occurred to the South (1897 M8.1 Shillong), West (1934 M8.4 Bihar) and East (1950 M8.6 Assam) of Bhutan, leaving an apparent gap over Bhutan itself. An event in 1713 shook the region but we have no reliable record on where it exactly occurred. Historical records before that time are scarce and do not mention earthquakes, although big events in one region may occur every several hundred or thousand years.

In the past years geophysicists from ETH Zürich and the University of Montpellier in France started a number of projects investigating the past and present geodynamic processes in Bhutan. The main questions are: How many earthquakes of what size occur in which regions of the country nowadays? How does the structure of the Earth look like beneath the surface? Is there any measurable trace of past big earthquakes? What is the current rate of deformation in the mountains? What is the potential magnitude of the largest earthquake that may one day happen in Bhutan?

A series of geophysical measurements have started in 2010 to answer these questions. The ongoing GANSSER project (short for “Geodynamics ANd Seismic Structure of the Eastern-Himalaya Region”) is a tribute to Bhutan’s famous geological discoverer, the late Augusto Gansser. In January 2013 project participants have installed 38 seismometers across the country that will stay in the field for about a year and a half.



The installed seismometer network in Bhutan. Each circle is a station. The road network is shown in blue.

Seismometers are extremely sensitive devices that detect the smallest motions of the ground, imperceptible to humans. By recording the signals from local earthquakes, including the very small ones, the network will monitor the seismicity of Bhutan and the surrounding region. Using signals from medium to large earthquakes occurring elsewhere on Earth researchers will be able to reveal the structure of the Earth's interior, using principles similar to medical imaging (e.g. ultrasound examination of pregnant women). These information together will provide important elements to understand the current and past evolution of the Bhutanese Himalayas.

The project is of course not a pure and dry scientific work of people sitting behind computers. In the first times it is about organizing an expedition. The field measurements require a long and tedious logistical effort to prepare and safely ship all equipment to Bhutan. With 1600 kg of material to be sent by DrukAir, without established connection to other airlines, it was a path to discover. After three months preparation in the basement and the office, 8 westerners travelled to Bhutan to meet 7 Bhutanese for the station deployment campaign during January 2013. The first days were spent on inventory and organization of our equipment that luckily arrived without problems. We also went "shopping": wood from different sawmills, metal rods from hidden barracks, sand from the Supreme Court construction site exchanged against empty sandbags, as well as batteries and plastic barrels shipped from India which were continuously promised to arrive "tomorrow". Getting ready took us as long as getting rid of jet-lag; then two teams departed to cover the Western and Eastern parts of the country in only 3 weeks.

The fieldwork provided us the privilege to see Bhutan in a very different way from how most people see the country. We had no established and fixed plans for the entire duration: these were continuously updated depending on our daily advance. This included estimating the driving times (something rather well known from our first geophysics project in 2010-2012), looking for potential accommodation possibilities (ranging from the university dorms in Gedu to the Royal Guesthouse in Damphu) and allowing time to search a suitable, quiet

site for our stations within a few kilometres of the plans previously drawn on a map. This site search and the following installation of the stations granted us memorable encounters with the people of Bhutan: always open, ready-to-help people who understand quickly the goals of the installation and the practical needs. They helped in digging holes, repairing electricity, providing a spot in their garden where we could pour a small cement platform, constructing a wooden shed, climbing on the roof to mount solar panels and GPS antenna and many other things. Our Bhutanese colleagues were excellent in negotiating at the right place and in the right manner, and also at helping building sites. At several places we were offered a meal or a tea, and we have usually left with the reassuring feeling that the station is in good hands.

By the end of January both teams have successfully completed the installation of their stations and returned to Thimphu to pack.

Behind Men-Andrin Meier and the local helpers lies the completed station BHE09: all the equipment is buried; only the solar panel (behind the man) is on the ground.

We were lucky to have had a month without major problems or accidents. While flying out from Paro and enjoying the beautiful Himalayan scenery, some already thought of the three station visits to come, the performance of the seismological network and the resulting findings. But most of the thoughts turned around the successful expedition and the important personal experience this month offered us.